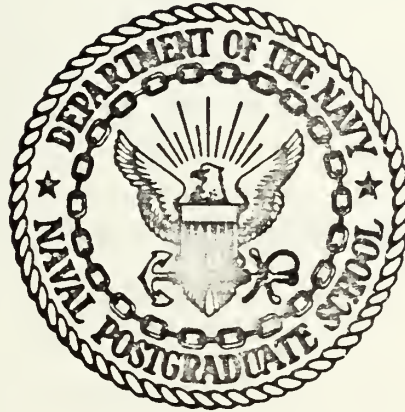


THE ECONOMICS OF
THE WEST COAST OIL SPILL CLEAN-UP
INDUSTRY

Christopher M. Stone

NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

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INDUSTRY

by

Christopher M. Stone

December 1974

Thesis Advisors: M. K. Block, D. R. Whipple

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The Economics of
The West Coast Oil Spill Clean-up Industry

by

Christopher M. Stone
Lieutenant, United States Coast Guard
B.A., Whitman College, 1968

Submitted in partial fulfillment of the
requirements for the degree of

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TABLE OF CONTENTS

I•	INTRODUCTION-----	6
II•	PURPOSE-----	8
III•	HISTORY OF THE OIL SPILL CLEAN-UP INDUSTRY-----	14
IV•	DEFINITION OF THE INDUSTRY-----	11
V•	THE COMMERCIAL SECTOR-----	20
	A• COMMERCIAL SECTOR DEMAND-----	20
	1. Actual Commercial Clean-up Demand-----	22
	B. THE COMMERCIAL CLEAN-UP FIRM-----	27
	1. Multi-functional Firm-----	27
	2. Clean-up Dependence-----	31
	3. Multi-functional Characteristics-----	33
	C• SOLUTIONS TO THE FIREHOUSE DILEMMA-----	35
	1. Solutions of the Secondary Firm-----	35
	2. Solutions of the Pure Firm-----	38
VI•	THE PRIVATE SECTOR-----	44
VII•	NON-PROFIT SECTOR-----	49
VIII•	PUBLIC SECTOR-----	56
IX•	INTERACTION OF SECTORS-----	64
X•	CONCLUSIONS-----	66
	APPENDIX A-----	69
	APPENDIX B-----	70
	APPENDIX C-----	71
	APPENDIX D-----	72
	BIBLIOGRAPHY-----	78
	INITIAL DISTRIBUTION LIST-----	79

I. INTRODUCTION

Since the late 60's enviromental issues such as clean air, clean water, recycling ~~wastes~~, etc. have become a frequent topic of discussion. Such interest has been confined to no one particular geographical area or age group, but spans interested individuals and larger special interest groups and from the political arena to various regulatory governmental agencies. This enviromental interest is wide spread and influences many aspects of our daily lives. Pollution has become a buzzword in almost everyone's vocabulary. Even the terms "environment" and "ecology" are now used in the names of local organizations, as well as some state and federal agencies. ¹ Recently an environmental theme has been used by several large organizations in advertisement as a reflection of this increased interest. ²

As a result of enviromental awareness of the 60's voluminous literature has been generated on the optimum level of pollution control. The purpose of this paper is not to add to the existing literature on the optimum level of pollution control, but rather to examine in some detail one industry actually engaged in pollution control -- the Oil Spill Clean-up Industry.

It is not the intention of the author to present a critique of the clean-up methodology or the strengths and weaknesses of past clean-up, but rather to discuss the development, economic aspects, and present status of the industry. A majority of the information on which this study

¹An example of a few agencies are: Enviromental Protection Agency (EPA), Washington State Deapartment of Ecology, Monterey Center for Enviromental Information.

²Exxon Advertisement, NBC Nightly News on 20 November 1974; Coors Beer, "Cash for Cans" advertisement.

is based was gathered by the author from individual clean-up firms with the purpose of developing characteristics of the industry and not of any one particular firm. Much of this information is confidential. Therefore where reference is made towards characteristics of a firm as a part of the industry, the identity of that firm will not be disclosed.

My sincere thanks goes to all the firms which have so willingly contributed specific financial data and other information upon which this study is based. Without such cooperation, this analysis of the industry would have been impossible.

II• PURPOSE

Profit is perhaps the fundamental motive behind the operation of any private business firm and thus for the industry comprised of like firms. Profits are so fundamental that they will not only determine whether a firm will enter a given industry or market, but also the extent of activity in the market.

For most firms, revenue is a measure of its activity most often thought of in terms of gross sales. The gross sales an industry can generate depends on the demand for the product or service of that industry. Excess demand for a product of an already established industry will drive up the price and cause new firms to enter the industry. A change in technology or in consumer preferences which creates demand for an entirely new product will cause either an already established industry to transfer resources to its production or cause formation of a new industry to meet the demand.

The demand for the output of a new industry is never known with complete certainty. At least some degree of "demand uncertainty" is present in every industry, but the extent of demand uncertainty varies from industry to industry. For some industries such as the baking industry demand for the product, i.e. bread, can be predicted with a high degree of confidence. Other industries are able to predict with only with low certainty the demand for output due to the nature of the product. In addition to the absolute demand being uncertain, the frequency with which the demand for services or product is encountered can also be uncertain. Many industries such as the building materials industry are subject to fluctuating demand within a fiscal period. If the fluctuations are truly seasonal they can be predicted with accuracy once the causes are understood. But if fluctuations exist for which the causes are random, true demand uncertainty exists.

A firm faced with uncertain demand both in respect to total demand and frequency of demand over time, might be compared to the local firehouse where the capability is maintained to cope with uncertain demand. The Oil Spill Clean-up Industry is similar to the firehouse because of the uncertain demand resulting from the random nature of oil spills. A prevalent feeling among the firms presently offering clean-up service is that this demand is random. As one member of the industry stated, "You can never tell when there will be a spill. You can go five or six weeks without a spill and then have five or six in one week". This situation of uncertain demand for firms attempting to offer oil spill clean-up services will be defined by the author as the "firehouse dilemma".

It might be asked then, that if demand is so uncertain why should any firm interested in making a profit attempt to enter the Oil Spill Clean-up Industry. A quick review of the spills in recent years reveals such massive clean-up efforts as the TORREY CANYON off the coast of England in 1965 with a clean-up cost of \$ 8 million, the Santa Barbara spill in 1969 with a cost of clean-up in excess of \$ 5 million dollars, and the Standard Oil Tanker collision in San Francisco Bay in 1970 with a clean-up cost of \$ 5 million. These examples point out the magnitude of demand for clean-up capability when a large or catastrophic spill occurs. In the event of such a spill the potential for huge profits definitely exists.

A high potential for profit from such large spills attracted resources from various sources into research and development for pollution abatement and clean-up equipment. Many small inventors and manufacturers attempted to develop equipment which would allow them to capitalize on the ecology movement. Likewise the lure of profits encouraged some firms to develop an inventory of equipment and provide oil spill clean-up services.

Outside the industry there exists a feeling that a

lucrative new market exists, and that anyone with a bale of hay and a pitchfork could make his fortune cleaning up oil spills. To date the limited number of firms having entered the industry in any given area indicates that views of such lucrative profits are probably not valid.

The purpose of this paper therefore is to analyze the structure of the industry with emphasis given to the extent of uncertainty within the industry, and how at least commercial clean-up firms have reacted to the "firehouse dilemma".

IV• DEFINITION OF THE INDUSTRY

The Oil Spill Clean-up Industry under consideration for this study can best be described as all organizations or firms on the West Coast of the United States which actively maintain a capability to clean-up oil or other hazardous substances from the surface of the water. To accurately examine the industry, all firms which have the capability of clean-up but do not advertise or offer clean-up on a commercial basis, i.e. which are not commonly thought of as a clean-up firm, must also be included. All sources of clean-up are considered part of the clean-up industry. However, since such an all inclusive definition of the industry includes entities with diverse purposes, intended uses of clean-up capability, and markets, the aggregate industry might better be broken down into four sectors: the commercial, the private, the non-profit and the government sector.

The commercial sector of the clean-up industry considered for the purpose of this study comprises those nine firms on the West Coast which offer their services to any party interested in purchasing clean-up activity. A list of the firms in the commercial sector is included as Appendix A. Determination of the firms which make up this sector was based on recent clean-up activity as observed by government regulatory agencies. The commercial sector can be categorized as those firms offering clean-up for hire.

The private clean-up sector differs from the commercial clean-up sector in that clean-up capability is maintained primarily for the "in-house" benefit of that firm, not for hire by other parties. This sector would include firms as small as private marinas desiring some clean-up capability, or firms as large as refineries frequently handling great volumes of petroleum products.

The non-profit sector consists solely of the oil spill clean-up cooperatives. The six cooperatives on the West

Coast which are listed in Appendix B vary as to the exact structure or the extent of capability, but all are a pooled effort of firms susceptible to oil spillage. This sector represents a different source of clean-up capability than the private sector, but it can be described as an extension of the private sector where some but not all the firms in the private sector have pooled their effort beyond their individual capability to provide protection in the event of a catastrophic spill.

Public sector capability maintained by the federal and state government is the fourth group of the Oil Spill Clean-up Industry. The majority of public clean-up capability presently comes from the U. S. Navy and the U. S. Coast Guard. State assistance by Washington, Oregon and California in terms of physical clean-up capability is at present non-existent.

For the clean-up industry, as defined, the basic question remains of how fixed costs are met with intermittent revenues. This question of costs and revenue has most emphasis within the commercial sector offering clean-up services for hire. For these firms commercial clean-up provides revenue and hopefully profit. Profit from clean-up activity has little or no direct impact on the other sectors of the industry. As an example a firm in the private sector maintains clean-up capability to take action on a spill originating from its own facility. Clean-up equipment for the private firm then is primarily an expense within the operation of a specific facility. It is one of the costs of doing business. The non-profit sector is prohibited by law from making a profit, but revenue is often received by the cooperatives to cover both the capital and operating expense of the cooperative and its equipment. The government does not maintain clean-up capability under a profit incentive, yet under certain circumstances revenue will be received for the use of government clean-up capability.

The initial examination of the clean-up industry and the "firehouse dilemma" of uncertain demand best originates in the commercial sector where profit is a primary factor.

III• HISTORY OF THE OIL SPILL CLEAN-UP INDUSTRY

Historical information concerning both the spillage and the clean-up of oil is quite sketchy and not well documented. Indications are that oil spills occurred in the form of natural seepage long before man started to use petroleum products as a source of energy. Such seepage originated from fissures in the ocean floor, much the same as the recent Santa Barbara spill but caused solely by nature. Evidence of early seepage is substantiated by archaeologists at the University of California, Santa Barbara who have found indications that burial baskets for the Sumach Indians were lined with oil from the beaches. In fact it is rumored that word of oil seepages brought people from the East Coast to Santa Barbara for the therapeutic value of the warm ocean breeze blowing in off the oil seeps. Thus it is conjecture that the first clean-up on the West Coast was by ancient California natives gathering tar balls off the beach as a source of material or fuel.

Mass production of the internal combustion engine and increased demands for petroleum products at the turn of the century changed not only man's lifestyle but also his environment. The gradual shift of vessel propulsion from sail and then coal to petroleum, compounded by the increased transportation of oil by ship was accompanied by an increase in the spillage and intentional discharge of oil into harbors and coastal waters.

Since the Rivers and Harbors Act of 1899, statutes have existed which prohibited such spillage. The 1899 law was mainly to forbid the discharge or deposits of materials into the waterways that would be hazardous to navigation. but this act also possessed authority to prohibit oil spills. It wasn't until the Oil Pollution Act of 1924 that a law was enacted which specifically prohibited the discharge of oil. But even this 1924 law said nothing about the responsibility

of picking up the oil once it was spilled, it merely prohibited the spilling of oil.

Historically the spillage of oil products was of concern to the spiller not for reasons of environmental protection, but rather for reasons of economics and safety. Spilled material was material which could not be sold. The presence of volatile fumes from spilled material in the harbor also provided the threat of fire to the facilities and a health hazard to personnel.

The early treatment of spills differed for the various ports on the West Coast. Most ports such as Seattle, Portland and San Francisco required no concentrated clean-up effort because the natural dissipation and evaporation of spilled oil was sped up by the flushing of normal tidal action or currents. Other ports such as Long Beach had less tidal action and some action had to be taken to remove the oil. Often when action was taken it was not a clean-up for environmental reasons but rather a matter of removing the oil so work could go on as usual.

The first indication of concerted clean-up on the West Coast was in California around 1934 when the California State Fish and Game Department took an active interest in clean-up. Prior to that time spills went unattended. There was no record of any clean-up taken when the LEHMAN STUART, a Union Oil tanker, went aground at the Golden Gate in 1927. Likewise when the AMERICAN HAWAIIAN ran aground at Point Mugu, just north of Los Angeles in the late 1920's all the fuel was dumped overboard with no consideration given to the oil, just to lighten the ship and get her off.

As early as 1931 public concern developed against oil pollution. The Los Angeles Times reported a meeting of an association, "Save The Beaches League", which met at Long Beach in October of that year to carry on an offensive against pollution. The purpose of the league was "to make investigations and recommendations, obtain legislation

and enforcement and call general meetings to plan the offensive against oil pollution".³

The thrust against pollution of the beaches was directed mainly against the prevention of spillage not towards the clean-up of subsequent spilled oil probably because of the lack of clean-up techniques. Awareness of the problem was becoming acute and policies towards intentional dumping were being reviewed. As reported by a newspaper article in 1931, "Commander E. H. Bruce told how the Navy cooperates by requiring all discharges to be made at least 15 miles offshore often dumping ballast waters 100 miles off shore to protect the beaches."⁴

In one west coast port clean-up equipment was developed in the early thirties. The first clean-up vessel on the west coast was at Long Beach in the early thirties owned by William Hutchison and William Simpson in an enterprise called Western Ship Service Company Ltd. The vessel, the PASADENA, was a converted lumber schooner which had been equipped with \$50,000 worth of tanks, pumps and mechanisms which separate floating oil from water. Although the PASADENA was designed for ship service, it was also capable of oil spill clean-up. A newspaper clipping for the Los Angeles Times of an unspecified date in the early thirties held what is perhaps the earliest record of clean-up on the west coast when it reported, "the vessel (PASADENA) was in operation at the Bethlehem Shipyards, where oil from the damaged hull of the CHARCAS had run onto the water."

The early clean-up efforts demonstrated at Long Beach were not typical for the west coast. As late as 1937 when the Associated Oil Company tanker, FRANK BUCK went aground on Ducks Burry Reef just outside the Golden Gate not too

³"Southland To Wage War on Beach Oil Pollution", Los Angeles Times, October 7, 1931, front page.

⁴Ibid.

far from where the Standard tanker collision took place 34 years later, no clean-up action was taken.

Early clean-up required only minimum equipment and technical knowhow, and was most often accomplished with the existing equipment and manpower of the firm which had spilled. Fire hoses and the vessels propeller wash, two implements readily available to the spiller, were used to flush the surface oil out into mid-stream or open, faster moving water where natural dissipation would be accelerated.

Early clean-up was not a technical problem, but merely an inconvenience necessary to resume business as usual. In the mid-sixties environmental concern began to accelerate and the previous practice of clean-out suddenly was no longer acceptable. As small, special interest groups became concerned, the general population began to demand a true clean-up effort. Government reaction followed first by reviving existing but unused legislation, and then by rewriting legislation to better meet the current intent of the government. A gradual transition occurred where the individual spillers realized that previous techniques were not acceptable to the general public or the government. In 1966, the Oil Pollution Act of 1924 was amended by Congress to require violators to remove spilled oil from navigable waters. If proper action was not taken to remove the oil, the Federal Government was authorized to remove the oil and seek reimbursements for clean-up costs. ⁵ Thorough clean-up had to be accomplished where at all possible.

At first small changes were instituted. Straw as an absorbent was substituted for the previously used carbonized sand which was a sinking agent that would adhere to the oil and sink to the bottom of the harbor. But soon it was

⁵Hess, Richard E., "Navy and Marine Oil Pollution -- An EPA View", Navy Oil Spill Control Conference Proceedings, 1-4 May, 1972, p. 11.

discovered that a little straw, genuine concern and a few boom sticks were not enough to efficiently remove the spilled material from the water especially where large quantities of oil were involved. Large firms realized they could conduct some clean-up themselves by investing in some relatively inexpensive equipment and utilizing company personnel. But these companies desired a more efficient and reliable method of clean-up. As a result a concerted R & D effort was initiated for improved methods of oil clean-up. Manufacturers and inventors were after a new a lucrative market -- oil clean-up equipment.

Yet by 1970 a firm faced with a potential oil spill clean-up problem had to decide whether to purchase equipment or rely on some outside source for clean-up. Although there was a multitude of new products suddenly on the market, all had varying capability, and potential consumers were unsure which if any of the new devices would be worth the high cost. Also with the rapid changes in technology, a firm was reluctant to invest heavily in a clean-up system which soon could have become obsolete. As a result of the complexities of clean-up, most small firms and many large firms choose to rely on an outside source for clean-up, if such assistance should be needed. But few if any commercial firms existed which could fulfill this demand for contracted clean-up. Thus clean-up assistance came from commercial companies which did not have a specialized clean-up capability, but had equipment that could be substituted into service for oil spill clean-up.

Initial clean-up devices consisted merely of log boom for containment, small vessels to deploy and maintain the boom, and an absorbent material which could be used to retrieve the oil from the water. Tug and barge companies often had the boom and vessels while an absorbent, straw, could be picked up at any feed store. Tug companies did not actively advertise or specialize in clean-up through the late sixties. Their services could be requested by a firm

with a spill and the charge was the going rate for the equipment. A major problem for these companies in performing oil clean-up services was that the tugs were usually slow, and thus the response time was high, for the purpose of containing oil. The marine-industrial clean-up companies had tank trucks and vacuum pumps for picking up the waste oil and transporting it from the scene of the spill to the disposal site. Again such companies were not in the specific business of clean-up, they merely made their services available, and the same problem of response time existed. The increased demand to have oil spills cleaned up in a prompt and efficient manner created the climate for the specialized Oil Spill Clean-up firm.

V• THE COMMERCIAL SECTOR

The commercial sector comprised of the nine firms on the West Coast offering oil spill clean-up for hire represents companies which are most commonly thought of as "clean-up firms". These firms are widely known throughout the maritime industry as a source of assistance should an oil spill occur. Additionally these are also the firms that come into the public view as profitable operations in the aftermath of a sizable spill when large clean-up costs are reported.

A• COMMERCIAL SECTOR DEMAND

Commercial clean-up demand is an expression of consumer preference for the service of having oil cleaned up. Demand must be considered in the context of a price-quantity relationship. Normal demand, expressed by a downward sloping demand curve, implies an increase in price will be accompanied by some decrease in the quantity of the service demanded. Such is assumed to be the case for commercial oil spill clean-up. It might well be argued that for clean-up in the short run the consumer is not in a position to ask "how much", but must seek available services at any price. In practice however the commercial price for clean-up is a result of what consumers are willing to pay to commercial firms rather than seek some other source of clean-up. The techniques of cleaning up oil lend themselves to a high rate of substitutability in that if the prices of one clean-up process are too high, then another technique will be employed. If clean-up firms were to raise prices to an excessive level, demand for commercial clean-up would tend to fall.

An example of one market where substitutability is not a factor is the "spot tanker market". This includes all tankers which are not on a long time charter but rather charge the market rate to haul petroleum products. The relationship of demand and supply is so critical in this

market that only a few too many ships in an area such as the Persian Gulf can drastically lower the transportation rates for petroleum. If there are too few ships in the same area the rate does climb rapidly. Rates which are calculated on a world scale index (to equalize the revenue per ton per day) rose during a three week period in May of 1973 from 92.5 to 210. ⁶ No close substitute exists for tankers, while commercial oil spill clean-up has very close substitutes.

1. Past Activity as a Measure of Demand

Commercial clean-up demand can be considered in terms of the past activity or the amounts of clean-up supplied by commercial clean-up firms. An initial step to evaluate past supply as an approximation of demand is to isolate a measure of activity common to all clean-up incidents. Items considered as a possible measure of activity were one or several of the following parameters: number of spills cleaned up, number of gallons cleaned up, gross revenue (sales) from clean-up operations.

Either the total number of spills which occur or the number cleaned up in a year (see Figure 1 and 2) would be one measure of activity. Although these measures would suggest the frequency with which the commercial sector is activated, it would not accurately describe the magnitude of the spill or the clean-up required. Total gallons spilled more accurately represents the actual magnitude of clean-up than the number of spills, but a gallon figure can also be misleading as a true indication of clean-up effort required. The type of oil spilled and the conditions under which it was spilled such as currents, weather, etc., are factors often just as important as the total gallons spilled in determining the total clean-up activity.

An optimal indicator of activity would jointly consider the number of spills, the magnitude of the spill by total

⁶Beman, Lewis, "Betting \$ 20 Billion in the Tanker Game", Fortune, August 1974, p. 146.

gallons, the type of oil, and in addition any other factors which add to the difficulty of clean-up. An all inclusive model to develop such a figure is not feasible due to the lack of data required on past spills and clean-up attempts.

An assumption can be made which will enable just one indicator, gross revenue attributed to clean-up, to be utilized as a measure which combines the favorable points of these other parameters considered. The assumption is that oil spill clean-up rates are comparable throughout the industry for any given spill cleaned up by any of the nine firms. Comparable rates means that all spills generating an equal revenue, for example \$10,000, to a clean-up firm are placing an equal demand on the commercial clean-up sector.

Even though faults may exist with revenue as a measure of activity, no other measure which will approach revenue as a common indicator is available. ⁷ Because gross revenue is by far the most accurate indicator readily available it will be used in this study to describe the clean-up activity.

1. Actual Commercial Clean-up Demand

The actual demand for commercial clean-up service on the West Coast presently is approximately \$2.6 million a year. An accurate description of how this demand is distributed throughout the industry requires the industry be looked at in geographical regions and the demand in these regions be examined over a period of time.

The location of commercial clean-up firms is presently distributed between the following five major ports: Seattle, Portland, San Francisco Bay, Los Angeles/Long Beach and San Diego. Location of several firms in one port and the mutual proximity of several of these ports enables the West Coast to be discussed in terms of three geographical

⁷One such fault is that spills with the same total revenue might differ greatly in the amount of clean-up and restoration. Since beach clean-up and yacht restoration are not functions of the clean-up industry, this would tend to weaken the assumption of comparable demand on the clean-up sector.

regions. The Pacific Northwest Region represents the coast of Washington and the northern coast of Oregon. Likewise the Central Coast Region includes southern Oregon plus northern and central California. The Southern California Region encompasses the area including Santa Barbara, Los Angeles, Long Beach, and San Diego. Each of these three regions contains three commercial clean-up firms. Table I. represents the activity in these three respective regions for the two and one half year period covered by this study.

As can be readily seen from Table I. there was an increase in total demand in 1973 over the demand for clean-up for 1972. But partial explanation for this increase is due to a moderate spill that occurred in the Central Coast Region and another sizable spill in the Northwest Region. A large spill in any year for any given geographical location will effect the total revenue from clean-up by as much as 50 to 100 percent. For example in the Northwest Region in 1973 one spill which involved the effort of two commercial firms and with clean-up lasting more than three weeks accounted for 59 percent of the total clean-up activity for the three clean-up firms in the region. One spill out of 96 clean-up operations for the Northwest Region accounted for over half of the total revenue from 1973. For the Central Coastal Region one spill accounted for 48 percent of the total activity of the same year.

Neither of the above mentioned spills were considered "catastrophic" in the sense of the TORREY CANYON spill or even the Santa Barbara spill, but rather were classed as moderate. The two and one half year period of this study was chosen for the purpose of representing a period considered as a normal demand range. It was purposely chosen so as not to include the Santa Barbara spill or the Standard tanker collision in San Francisco Bay. This enabled the study to examine how the industry behaves when no catastrophic spill occurs. Yet even one moderate

TABLE 1

Commercial Sector
Annual Gross Clean-up Revenue

	1972	1973	1974 (6Mo)
Northwest	170,086	754,865	236,364
Central Coast	617,922	921,684	163,454
Southern Cal	605,198	925,422	796,933
	-----	-----	-----
Total	1,393,206	2,601,971	1,196,751

Source: Data collected from commercial clean-up firms by author.

spill will drastically effect the observed activity for the commercial sector which has been measured in terms of revenue.

A segmented look at past demand in terms of minor, moderate and major spills will place into prospective the impact of these infrequent large spills. The breakdown of spills into three segments will be based on the revenue of the individual clean-up. A "minor" spill is established as an individual spill with a gross revenue under \$35,000, a "moderate" spill between \$35,000 and \$500,000, while a "major" spill is over \$500,000 in clean-up costs. The division between the major and moderate spill is strictly arbitrary, as any spill moderate or larger may completely bias the demand figures for the whole West Coast.

To substantiate this division of minor to moderate spills a frequency distribution of various sized spills has been developed. Table 2 shows the distribution of 400 spills as a representative sample of total spills. This data includes all clean-up incidents encountered by three of the nine commercial firms for the two and one half year period of the study. Table 2 clearly demonstrates that a large majority of the clean-up incidents are small in nature. It is seen that 81.8 percent of all spills cleaned up are in the \$1,000 to \$5,000 range, where as spills over \$35,000 for the same period represent only 2 percent of the number of spills. However when the total revenue is considered for all clean-up incidents within a given clean-up size category, it is seen that total revenue is not so heavily dependent upon the small sized spills. As an example the 81.8 percent of all clean-up incidents which were less than \$5,000 accounted for only 27.7 percent of the total revenue for these three firms. It is also of interest to note from table 2 that all minor spills with a clean-up revenue under \$35,000 accounted for 97.9 percent of the total clean-up incidents but only 64.1 percent of total revenue.

TABLE 2

Distribution of Spills
by Frequency and Revenue Size

Category	Spills	\$ Revenue
	(percent)	(percent)
\$0-1,000	41.3	4.7
\$1,000-2,500	29.5	9.2
\$2,500-5,000	11.0	13.8
\$5,000-10,000	9.8	14.5
\$10,000-20,000	4.8	14.4
\$20,000-35,000	1.5	20.5
\$35,000-100,000	1.8	20.5
\$100,000-over	.5	15.3

Source: Total of 400 clean-up incidents for three firms
1972, 1973, and first six months 1974.

Such strong dependence on the minor spills by the commercial sector suggests that any demand anticipation by these firms would be placed primarily on the minor spills with little dependence being given to the moderate and major types of spills. A two-part measure of demand for all nine firms can be constructed by separating out the minor spills from the moderate and major spills. This is represented in Table 3. By segmenting demand into the two parts, the original "firehouse dilemma" of uncertain demand can better be analyzed in terms of the commercial sector.

Any spill of the moderate or larger clean-up effort can be demonstrated to be a "highly uncertain" occurrence, and hence will be considered with only little weight by the commercial firm. Conversely the aggregation of minor spills reflects a relatively smooth and certain demand one adjusted by deleting the larger spills.

B. THE COMMERCIAL CLEAN-UP FIRM

No typical commercial clean-up firm exists. The nine firms on the West Coast vary not only in the total size of the firm but also in the extent and type of clean-up equipment available. As a result firms also vary as to capability and the exact type of clean-up best performed. Often differences between individual firms are a result of regional features such as the type of harbor, commerce in that area, and what type of spills commonly required clean-up in the past. Such differences between firms are subjective to the extent that no optimal size or capability appears to have been determined on an industry wide basis. The nine commercial clean-up firms have at present a total clean-up inventory in excess of \$ 1.3 million. This includes approximately 12,000 feet of assorted containment booms and seven self-propelled skimmers.

1. Multi-functional Firm

Common to all clean-up companies is the characteristic of being a multi-functional firm. All firms

TABLE 3-A

Minor Spill Clean-up Activity by Area

Qtr	Northwest	Central Coastal	Southern Cal	Total
1	20,467	132,312	203,023	355,802
2	57,164	81,877	136,828	275,809
3	44,113	101,296	94,177	239,586
4	48,342	146,390	171,170	365,902
5	75,716	106,942	145,751	328,409
6	53,473	67,107	202,902	323,446
7	135,744	138,856	178,079	452,697
8	121,223	182,172	280,672	584,067
9	102,048	71,326	336,543	509,917
10	47,316	47,530	281,806	376,555

TABLE 3-B

Major Spill Clean-up Activity by Area

Qtr	Northwest	Central Coastal	Southern Cal	Total
1		77,089		77,089
2				-0-
3	426,745	36,774		36,774
4		42,184		42,184
5	38,000	426,607		464,607
6				-0-
7				-0-
8			118,000	188,000
9	35,000	44,598		79,598
10	52,000		178,584	230,584

Source: Data collected from commercial clean-up firms by author.

in the industry have one or more revenue generating activities. Some of these additional functions are related to environmental protection other than the service of cleaning up an oil spill. The characteristics of the "other" functions are not common throughout the industry. Activities in the commercial firms along with clean-up include the following: marine-industrial cleaning, pollution prevention, pollution control equipment manufacturing and sales, and tug and barge service.

a. Marine-Industrial Cleaning Service

The marine-industrial cleaning industry consists of tank cleaning and waste removal operations for all types of vessels and manufacturing firms. Equipment required in this operation includes tank trucks with vacuum suction capability, cleaning components, pumps, waste transfer and sometimes waste disposal capability. Firms offering the marine-industrial cleaning service are found in all major West Coast industrial centers and ports. The local economic conditions including the extent of shipping, oil refining, oil storage, chemical processing, etc., determine the size of the marine-industrial cleaning capability of any given area. Through the nature of the work performed and the equipment utilized, marine-industrial cleaning is extremely compatible with oil spill clean-up.

b. Tug and Barge Service

Tug and barge companies involved either in harbor ship services or in long distance barge transportation provide numerous vessels or other mobile platforms from which to conduct oil clean-up. The organizational structure of these companies with 24 hour dispatch and continuous harbor activity also make this type of firm highly compatible with oil spill clean-up.

c. Pollution Prevention Service

Oil spill prevention and reduction is a service which closely parallels but yet is separate from clean-up. Prevention and reduction of oil spills consists of

activities such as pre-deployment of boom or oil containment systems, or an on-scene standby capability to minimize damage if a spill should occur. Such services are not designed so much with the absolute prevention of spills but rather with the reduction or minimization of clean-up once a spill should occur.

Preventive services differ from actual clean-up in that oil is not on the water. A clean cut difference between prevention charges and clean-up charges does not exist if a spill occurs. Once a spill occurs prevention becomes the initial phase of clean-up. If a spill does occur while prevention service is in use, the pre-deployed boom automatically contains the oil while any standby equipment can be put to immediate clean-up use. There is no great time delay for transportation and thus clean-up efforts are not hampered by the loss and dissipation of oil. A major difference is that pure oil spill clean-up activity is more uncertain than prevention-reduction service which has a clean-up demand based on the activity for which pre-deployed or standby capability is required.

This service is directed towards a clientele which possess a high probability of spilling. The on scene or pre-deployed system can result in enormous savings by reduction of necessary clean-up and pollution should a spill occur. Where no spill occurs this prevention service cannot be included as clean-up activity. Thus the need for a separate category of "prevention service".

d. Pollution Equipment Manufacturing and Sales

Manufacturing of pollution clean-up equipment includes such items as containment booms, absorbents, various pick-up devices for the retrieval of oil and oil soaked debris, or other equipment for clean-up. Retail sales of equipment manufactured or of equipment purchased from manufacturers also is compatible with pollution abatement but is still a separate activity.

Numerous manufacturers and distributors of oil

spill clean-up equipment have no clean-up capability to be offered as a service. That is many equipment manufacturers are not faced with the demand for clean-up, but merely the demand for clean-up equipment. These two demands represent different markets and are not necessarily correlated. Sales revenue is geared to the level of protection thought necessary throughout all sectors of the Oil Spill Clean-up Industry. Commercial clean-up activity is dependent upon the actual occurrence and size of spills for which commercial clean-up is required. The level of protection and therefore sales might even be inversely related to demand for commercial clean-up services if it represents a shift from commercial to private or non-profit clean-up.

2. Clean-up Dependence

Economic interest in the commercial clean-up sector is directed toward the dependence of commercial firms on clean-up as a source of revenue. The dependence of a firm on clean-up for revenue measures the importance of being able to predict demand for clean-up and the consequences of facing random demand. If it represents only a small portion of a given firm's activity and that same firm has relatively few resources devoted entirely to clean-up, the consequences of random demand are minimal. If a sizable portion of one firm's income depends on clean-up, and a large share of the plant and equipment of that firm is devoted solely to clean-up then consequences of random demand are vital.

This author has established an arbitrary classification of the firms based on their clean-up dependence. To differentiate between those firms dependent or relatively independent of clean-up the terms "pure" and "secondary" have been introduced to describe the clean-up firm. This classification has nothing to do with the overall capability of the firm in clean-up activity, but is used only to describe the dependence of a firm on clean-up activity for revenue as a part of total sales.

An arbitrary breakoff point between a "pure" firm

and a "secondary" firm will categorize a firm as pure if more than half of the firm's total revenue is derived from clean-up activity. Such a low breakoff point initially suggests that even a pure firm is not completely dependent on clean-up. It should be noted that environmental protection related activities such as pollution reduction, pollution equipment manufacturing or sales are not included in the category of clean-up activity for the determination of whether a firm is pure or secondary. This category of pure versus secondary firm deals solely with oil spill clean-up as a percentage of total revenue, not from clean-up related activities. Thus firms which deal with clean-up related activities in addition to clean-up are not favored in the sense of being a pure firm.

Of immediate interest is the fact that only three of the nine firms included in the commercial sector qualify as pure firms. Clean-up dependence for the individual firm ranges from a high of 100 percent to a low of .9 percent for any of the two and one half years. For the entire clean-up sector the dependence on clean-up was 27.5 percent for the entire period. Within individual firms the dependence on clean-up changed from 1972 to 1973 and 1974. The three firms designated as pure decreased in dependence each year. These three firms remained in the pure category for 1972 and 1973 but for the first six months of 1974 only one of these firms was still pure. Of the secondary firms one gained in dependence each year while the others had a higher dependence in 1973 than either 1974 or 1972. This increased dependence in 1973 is partially a result of several moderate spills occurring in that period. With the exception of these moderate spills the tendency for all the secondary firms was to increase slightly in dependence for 1973 with 1974 generally being lower than 1972.

There was an increased tendency by the three pure firms to rely more on their clean-up related functions such as pollution equipment manufacturing, sales and prevention

services in the later years. Over the three year period the pure firms remained almost entirely in pollution related fields. But the specific dependence on clean-up activity declined with the increased vertical integration into various phases of clean-up related functions.

Relatively low dependence on clean-up throughout the industry suggests the commercial sector as originally specified is not pure in the economic sense. When an industry (such as the baking or the steel industry) deals basically with a single function, the industry can be analyzed in terms of the one basic product or service. The commercial clean-up industry does not fall into this simple, clear-cut category, and can better be described as a collection of multi-product firms all sharing at least one common product, oil spill clean-up.

Although a discussion of the proper classification of the commercial clean-up sector within different industries might be of interest, the outcome is merely academic. Commercial clean-up is a sizable and important aspect of the overall clean-up industry. The existence of the commercial sector therefore by definition must be assumed to complete a study of the total Oil Spill Clean-up Industry.

3. Multi-functional Characteristics of the Firm

One of the criteria which determines the type of functions accompanying any particular clean-up firm is the local economic conditions of the region. An examination of the multi-functional firms by different geographical regions discloses the fact that a relationship does exist. Among the three firms of the Northwest Region, one is a pure clean-up firm, another a pollution equipment manufacturer and distributor, and the third is an independent division of a tug and barge operation. In the Central Coastal Region one of the three firms again is a pure clean-up firm with associated functions of spill prevention and reduction as well as equipment manufacturing. In the Southern California

Region, all three firms are secondary. The other two firms in the Central Region have as a primary function marine-industrial cleaning and associated services, and are involved in the marine-industrial cleaning operation. The geographical trend is apparent in the three different regions. Two pure firms with little input from marine-industrial cleaning are in the Northwest Region, while conversely in the Southern California Region all firms are secondary and have a common function of marine-industrial cleaning as the primary activity.

This difference between the type of clean-up firm by regions directly relates to the economic structure of the region. A compilation of the Army Corps of Engineers, waterborne commerce statistics show that Puget Sound ports have handled 52.2 million barrels of petroleum products in 1972. Portland area including Astoria and the Columbia River for the same period handled 59.6 million barrels. In the other two regions, San Francisco Bay area handled 150.1 million barrels while Los Angeles/Long Beach and San Diego handled 161.5 million barrels. While there are five refineries in the Northwest region (all in Puget Sound) such refineries are relatively spread out. As a result a concentrated marine-industrial cleaning capability does not exist, as contrasted with Southern California where a large number of refineries are concentrated in relatively close proximity. Of further significance is the number of wells located in Southern California which also require marine-industrial cleaning services.

Because of the differences in the size and concentration of petroleum transferring, refining and storing in the three West Coast Regions, there also exists a difference in related industries such as marine-industrial cleaning. The local economic conditions of Southern California have supported the marine-industrial cleaning industry which is extremely complimentary to the Oil Spill Clean-up Industry. The transition to oil spill clean-up was

natural with no large capital expenditures necessary. With different economic forces in the Central Coastal Region and in the Northwest Region, a different approach to the development of the clean-up firm was undertaken and greater capital purchases had to be made.

It is because of these differences in economics of the regions that two of the three firms in the Northwest Region are pure firms, while all of the clean-up firms in the Southern California Region are secondary and have marine-industrial cleaning as their primary function.

C. SOLUTIONS TO THE FIREHOUSE DILEMMA

The acknowledgement of multi-product or multi-function firms and a predominance of secondary firms in the commercial sector points out an initial answer to the question of how firms adjust to certain costs and stochastic or uncertain revenue. Since the structure and clean-up dependence for pure and secondary firms differ, the solution of the "firehouse dilemma" for each might be examined separately.

1. Solution of the Secondary Firms

The short run answer for secondary firms is that costs of maintaining clean-up capability need not be matched by revenues on a monthly or even a quarterly basis. Such short periods of insufficient revenue might be sustained by revenue from the major functions of the firm. Then for some specified longer period, such as one or even two years, revenue would be expected to not only exceed cost but carry a reasonable profit including a risk premium. Over the long run if revenues did not prove to carry cost, then it would suggest that oil spill clean-up be dropped as a function of that firm.

The secondary firms are relatively independent of oil clean-up as a source of revenue so that any risk associated with uncertain activity in oil clean-up can be carried by the other functions. The spreading of risk is an

approach all firms have taken, but secondary firms are far better equipped to spread this risk among their major activities.

Within the secondary firms there is a high compatibility of the major activity to that of oil spill clean-up. Other functions of the secondary firm are not related to oil spill clean-up, but are functions such as marine-industrial cleaning or tug and barge operations which can easily adapt major equipment to an oil spill clean-up function. This compatibility allows considerable substitution of equipment from the primary activities of the firm into oil clean-up. Rather than have specialized oil spill clean-up equipment remain idle, secondary firms use equipment which is adaptable to clean-up but is still employed in the primary activity of the firm. Then when a spill occurs the equipment is diverted from the lower priority, normal function to the higher priority task of oil spill clean-up. Thus an extensive inventory of specialized clean-up equipment need not be kept on hand with a low probability of use. Clean-up usually entails overtime which represents an increased utilization and return on the equipment. Lower priority use of the equipment can be resumed once clean-up is complete.

The example of marine-industrial cleaning is a case in point. Tank trucks, pumps, hoses etc., which normally are used for industrial or marine cleaning can be converted to oil spill clean-up with minimum adaptation. Tank trucks which are scheduled to work forty hours a week can be quickly transferred to oil spill clean-up with utilization of trucks often far in excess of forty hours per week.

Within the secondary firms the feeling was prevalent that clean-up was a source of "bonus revenue" because of the added utilization of equipment. The other factor that encouraged many of the secondary firms to continue offering a clean-up service is that many customers served by the major functions of the firm were also in need of spill

clean-up from time to time. Thus offering clean-up service by many of the secondary firms was a normal extension of their existing service line.

A common characteristic of the secondary firm in their approach to the oil spill clean-up service is the reluctance to invest in extensive equipment that could be used only for clean-up. As a result the clean-up effort of a secondary firm often closely parallels the major activity with respect to method of clean-up. That is to say a secondary firm specializing in marine-industrial cleaning would be more inclined to use a fleet of tank trucks for clean-up than to purchase a "class I skimmer" for harbor clean-up efforts.

This relates to a revenue-effectiveness ratio for different types of oil spill clean-up equipment. Secondary firms are more inclined to use existing equipment for clean-up to which they are already committed in their primary activity. The rate charged for this equipment is the same rate as when employed in a non clean-up activity regardless of the comparative efficiency of the equipment to pick-up oil. If the efficiency or capability of this multi-functional equipment is less than another piece of speciality equipment, usable only for clean-up but charging the same rate, then the use of the multi-functional equipment with a high revenue-effectiveness ratio would be more costly for the party paying for the clean-up.

The above situation could work in reverse. The charge for multi-functional equipment could be less than specialty equipment because the fixed cost of the multi-functional equipment is spread over clean-up and non clean-up activities. If the lower cost is passed on to the consumer, a lower revenue-effectiveness ratio may result, depending on the efficiency comparisons. Firms passing on such cost savings could perform more efficient clean-up to the advantage of the party paying for clean-up.

Characteristics of all spills change and as a result

little specific information exists to compare the efficiency of skimmers to tank trucks. Because of a lack of quantitative comparisons a generalization of the advantages or disadvantages of secondary firms using multi-functional equipment would be impossible to verify. But the possibility that such differences might exist must be recognized.

2. Solution of the Pure Firms

Unlike the secondary firm which does not have to rely solely on revenue from clean-up, the pure firm by definition is much more concerned with clean-up revenue. The pure firm cannot adopt too long term an approach to revenue distribution, as it would be difficult to operate from period to period on the presupposition that sufficient revenue will eventually materialize.

One pure firm in the industry is an independently incorporated firm privately owned by three other marine related companies. Although an undefined exchange of expertise and cost advantages exists from the owners to the clean-up firm, there is no financial support by the owners to compensate the firm for fluctuating demand. Another of the pure firms is a separate financial division of a much larger marine oriented company with an independent requirement to generate sufficient revenue. Continued operation of these two pure firms is very much dependent on the demand for oil spill clean-up, plus any additional functions or sources of income which would spread the risk of random demand.

A discussion of the pure firm should determine whether demand for clean-up service is predictable and large enough to support a completely pure firm at an effective level of operation. Low level demand would be sufficient to support a clean-up firm only of such small size that the basic economies of scale within the clean-up operation could not adequately be exploited. Although there is no minimum limit set on the size of the firm, a clean-up activity would

as minimum have to support a manned response of containment and clean-up capability. For a pure firm with no other functions this might require at least two men available full time and a minimum amount of equipment to contain and pick up oil.

The data presented in Table 3 (page 28) can be analyzed to determine both the random nature and magnitude of demand. Figures 3, 4 and 5 are graphical representation of the quarterly activity for each geographical region over the ten quarters of the study. This data in Table 3-A and Figure 4 has been smoothed by eliminating any spill in excess of \$35,000. For all three of the geographical regions it can be seen that the aggregate revenue from minor clean-up is not as random as had originally been characterized. This suggests that demand for the clean-up of minor spills is somewhat predictable but at a relatively low level of activity. Rather than random demand, a better description of the problem facing the pure firm might be inadequate demand for oil spill clean-up. There isn't sufficient clean-up demands for the \$5,000 to \$35,000 spills to warrant a pure clean-up firm of adequate size to meet these spills.

The situation is that the pure firm has the option of gearing up solely for the small spills or perhaps maintaining a slightly larger capability and anticipating greater revenue on a larger spill if one should occur. It should be noted that the secondary firm has the potential to devote as much or as little of the multi-functional equipment to spill clean-up as is required up to the limit of the firm's equipment. The bigger the spill the more that can be substituted from the primary activity. The pure firm doesn't have this option. It must decide knowing (or even not knowing) its market share of regional demand whether it will attempt only to meet this predictable demand, or face the uncertainty of a larger spill potential. Even in the event of a larger spill, a pure firm with only the

capability for a small market share could at least exercise its limited clean-up capability in assisting on the large spill. If such a firm does equip itself to clean up spills of the \$35,000 to \$100,000 category, other ways must be sought to cover costs if the larger spill doesn't occur. Pure firms might develop some other function such as pollution equipment sales, spill prevention and reduction services, or even to solicit prepaid support from the potential clientele in the form of subscriptions.

The level of activity at which the relatively certain demand for spill clean-up exists is on the average \$100,000 for each firm per year. This is too low to sustain any sizable clean-up effort. One firm stated that to maintain a rapid response capability of two men and a boat year round would cost in excess of \$90,000 for labor alone. Thus it is questionable whether this low but certain activity is profitable for a pure firm. As mentioned earlier \$100,000 a year extra business is considered profitable by the the secondary firm with multi-functional capability.

All three of the pure firms in the commercial sector of the industry have been forced to seek other sources of revenue so as to maintain a higher level of response. One firm has diversified into the manufacturing of equipment, not only to be used as materials in their own clean-up operations, but also to be sold in the clean-up equipment market. Two of the three firms were unable to diversify to an extent which would provide sufficient revenue, so both instituted variations of prepaid subscription systems to assure adequate funds. A prepaid subscription system can be equated to an insurance policy for companies which are potential spillers. The basic purpose is to maintain a viable clean-up effort in a region where an otherwise uncovered potential for a spill exists. This works to the benefit of those companies which might demand clean-up for a future spill. It also works to the advantage of the

clean-up firm. The revenue to the commercial clean-up firm is no longer totally uncertain. The government also stands to benefit from having a commercial clean-up service available, since the government regulates clean-up by violators as well as possibly demanding clean-up for government-caused spills.

The presence of pure firms in an area does not imply that complimentary firms such as the marine-industrial cleaning firms are not also present. The size of any complimentary firms which are in the same area as a pure firm, however, is not sufficient to carry oil spill clean-up as a profitable sideline function. Both pure firms turning to clean-up subscriptions were originally founded under the expectation of obtaining sufficient profits from clean-up, however both found it impossible to maintain required clean-up capability based on spill clean-up revenue.

In a region where a clean-up firm cannot be carried by its own revenue, the firm can either be supported by those in need of its service or allowed to go under. The only alternative to those firms who stand to potentially require clean-up assistance, yet would have to cover their own clean-up at a greater cost and less efficiency if the commercial firm folds, is to support its existence.

Subscription can be a commitment in the form of a support payment by all parties who stand to gain from clean-up. The amount is the difference between the unprofitable revenue of clean-up at present demand and a reasonable return of profit for the commercial firm's investment. This amount can be shared in any form agreeable to the sum total of firms in need of the service. Such an arrangement would assure continuance of the clean-up firm.

The most common form of subscription in the commercial sector is more than just a straight subsidy as described above. It most often takes on the form of a two-part tariff. In return for subscribing to the pollution service, services when needed by a subscriber are received

at a discount rate. Thus, depending on the size of the subscription for the individual firm, the size of discount and the severity of a spill incurred, the total cost of clean-up to the subscriber even including the subscription costs might well be less than the total cost of clean-up at the non-subscriber rate.

Subscription as a form of prepaid clean-up is in two respects an insurance transaction for the potential spiller. First it assures or insures clean-up capability will be available if needed. Secondly it insures costs of a spill of considerable size or severity would be reduced by a constant amount analagous to a coinsurance policy. An alternative to subscription for the clean-up firm would be merely charging higher prices to cover costs. This would radically increase revenue when a spill occurred. Charges consist primarily of those for equipment and labor. If labor prices are charged in excess of a comparable rate for marine oriented functions, the demander of clean-up would substitute personnel where at all possible. If equipment charges were excessive there would be a tendency either to substitute less efficient equipment or avoid clean-up altogether. The two-part tariff presently used by several commercial firms is already charging a higher price. If demand is insufficient even a higher price will not cover costs. Subscription removes some uncertainty and thus adequate clean-up is not totally dependent upon a sufficient number of spills occurring in any one period.

Prepaid clean-up can also take a form different from the straight subscription or coinsurance of the two-part tariff. Presently one pure firm in the commercial sector has combined a policy of prepaid clean-up and a fee for service payment for pre-deployed containment system into an insurance package. The customer pays a fixed fee every time the containment system (in this case owned by the customer) is deployed, but included in the charge of the fixed fee is the guarantee of clean-up of any oil spill within the

containment system up to a specified amount, normally \$10,000. The philosophy behind this arrangement of prepaid clean-up rests with the fact that containment is a major portion of the clean-up. It also provides additional revenue to the firm as a hedge against the uncertain market demand for clean-up. The insured clean-up provision of this policy is contingent upon the purchase and deployment of the system from the firm in the commercial sector. If such a system is applied extensively to any market area it would closely parallel insurance both in the execution and the actuarial determination of rates.

VI• THE PRIVATE SECTOR

In an attempt to examine the entire spectrum of clean-up potential, an area of clean-up capability which must be recognized is the private sector. This sector accounts for the in-house clean-up effort developed by those firms in a potential position to spill.

The private sector effects the clean-up industry in three different respects. First, it is from this sector that a portion of demand for clean-up originates. Secondly, the firms in the private sector, by having developed a first strike clean-up capability, provide additional clean-up resources within the Oil Spill Clean-up Industry. The third effect on the industry is the capability to pool equipment from several firms in the private sector to combat a spill.

This sector does not attempt to market clean-up services to other potential users. It is an in-house capability primarily for the protection of the individual firm. This relates to the urgency of timing in clean-up. If immediate clean-up action is taken then the chances of a thorough clean-up are much greater with subsequent reductions in clean-up costs and damage to the environment.

The development of private clean-up for firms was a result of various factors. Some firms could not rely on the commercial sector to handle all clean-up needs because of lack of existing facilities or the distance of the firm from existing facilities. Other firms chose to develop private capability because of cost advantages. Firms with a high potential for spillage could train company personnel and utilize company purchased clean-up equipment, thus avoiding excessive rental and labor charges if a spill occurred. A final reason for maintaining a private capability was the fulfillment of government regulations. Effective 1 July 1974, firms handling petroleum products between two vessels or a vessel and shore were required to maintain equipment or have at their disposal adequate equipment for

containment of oil should a spill occur. ⁸ The availability of clean-up equipment enables these firms not only to apply initial clean-up efforts in the event of a spill, but also small spills could be cleaned up entirely with company equipment, eliminating the need to call in outside help.

The maintenance of private equipment and exchange of equipment between firms in this sector makes the clean-up potential of the private sector a significant portion of the Oil Spill Clean-up Industry. A clean-up demand which might have been met by the Commercial Sector is now in part being met with the in-house capability of the private firms. As more firms develop some minimal in-house capability, more clean-up will shift from the commercial to the private sector.

The size of the in-house clean-up operations for the firm often depends on the vulnerability of the individual firm to spillage. While all firms in the sector have acquired the equipment for the first strike capability, those firms handling larger quantities of petroleum product often maintain an extensive private clean-up capability. When firms in the sector incur clean-up requirements that exceed their in-house capability additional clean-up resources are immediately brought in from other sectors in the industry. Size of the firm and individual management preferences determines whether outside clean-up is contracted to take over the clean-up with continued assistance from the in-house capability, or whether outside efforts merely augment the existing clean-up structure within the firm. Major firms are prepared to handle most any size spill and just expand their organization to bring in additional equipment and personnel as necessary. Other firms are prepared only to meet the first strike requirement

⁸Title 33, Code of Federal Regulations, Part 154.545 p. 639.

and then relinquish clean-up responsibility once their in-house capability is exceeded.

A measure of relative clean-up capability for the private sector would be of interest to compare this sector to others in the industry. Technically any firm which maintains clean-up equipment is included in this sector. To totally identify the private sector is then an unrealistic objective due to the large number of firms which have or intend to have clean-up equipment in the near future. Further some firms which have this in-house capability have classified this as proprietary information.

To obtain an indication of the capability and magnitude of the private sector, sixty firms were polled with the questionnaire enclosed as Appendix C. The intention of this survey was not an attempt to accurately quantify the total capability of the private sector so much as it was to verify the relative aggregate strength of this sector's clean-up capability. Utilizing returns from this questionnaire and information collected elsewhere, a low estimation of clean-up strength could be made concerning this sector. Information as to the utilization of clean-up equipment is unavailable in comparison to the commercial sector, as revenue is not incurred from in-house clean-up and cost data is not consistent. This survey disclosed that as a conservative estimate 75,000 feet of various types of containment boom is maintained by the private sector and is valued at approximately \$500,000. Such an estimate is based on data of 61 firms documented through the questionnaire and various contingency plans to have 66,000 feet of boom.

Such figures are incomplete and therefore inconclusive as to an accurate account of the private capability, but they do suggest that equipment presently maintained by the private sector can safely be estimated to be in excess of one million dollars. The share of total clean-up demand met in-house by the private sector therefore is considered significant within the industry. This material is

distributed in small lot sizes at well over one hundred locations up and down the West Coast. While some of this equipment might be available to be utilized on a large spill away from the private firm, most of it is committed to standby and sometimes even pre-deployed protection for the individual firm. It therefore must not be concluded that the private sector has 75,000 feet of boom which can immediately contribute to a massive oil spill clean-up effort. But for the individual firm this material represents an internal first-strike clean-up effort for small spills independent of the commercial sector. The aggregate effect of this small spill capability does have a measurable effect on the overall industry.

Limited response of the questionnaire indicated that over the two and one half year period 58 spills had been cleaned up by private sector resources. For those firms responding this would suggest slightly more than one spill per year for each firm. At least a third of the responses had no spill for any of the periods. The cost figure is of little comparative value due to the numerous possible ways of figuring cost. Considering the possible error in the cost figure, the response indicated that with the exception of one clean-up in excess of \$100,000 the average cost was \$3,000, with the median cost closer to one thousand dollars. Again even though these cost figures are not reconcilable with the revenue figures of the commercial sector, The utilization of private sector capability is indicated to be quite low, as it is designed for use only within a single firm rather than being offered to many companies on a commercial basis.

The incentive for the private firm to maintain clean-up equipment is the availability of the ready-response capability. It might be questioned why firms who need clean-up for their own use do not expand and try to offer clean-up on a commercial basis as well, thereby increasing utilization of the equipment. At present there is no member

of the private sector doing this. Private clean-up capability is considered only a cost of doing business. Compared to the total volume of business this cost of clean-up equipment constitutes only a small part of total expenses. High utilization of the equipment is not so much a factor for private firms, as the maintenance of standby capability. If the clean-up capability was expanded on a commercial basis it might possibly jepordize the in-house capability if on-site equipment were required on a large spill elsewhere.

Due to the uncertain demand for external use it has been easier to maintain clean-up as an in-house expense, rather than to drain management and company resources to develop a new function.

VII• NON-PROFIT SECTOR

The non-profit sector was developed to fill a void in existing clean-up capability in the industry, rather than to compete with existing commercial firms. In 1967 in the wake of publicity from the TORREY CANYON incident the president of American Petroleum Institute, Mr. Frank N. Ikard recommended that member companies of the API develop a cooperative approach to the problem of oil spills and clean-up. It was visualized that such cooperative organizations would "function much as volunteer fire departments do, and their mission would be to contain and clean-up oil spills".⁹

Even prior to this attempt by the API to encourage cooperatives on a nation wide basis, several such organizations were functioning on a local basis. New Haven, Connecticut started a co-op in 1964 with the purchase of containment and clean-up equipment as well as the development of an emergency plan. (In addition to firms in a position of potential spillage, the New Haven Fire Department was also an active member of the co-op.)

The major purpose of the cooperative is joint protection against spills of such magnitude that commercial clean-up firms or private response capability might not be able to adequately meet the demand. The probability of occurrence for such large spills is so uncertain that no commercial firm would be willing to invest in the required equipment and organizational structure to meet this demand. Several commercial firms suggested it was difficult to obtain satisfactory returns from an \$80,000 skimmer much less a \$400,000 investment thought necessary to even approach the large spills adequately. The co-op then supplies clean-up capability where the degree of uncertainty in demand prohibits the commercial firm from continuing with

⁹"Oil Spill Clean-up Cooperatives", American Petroleum Institute, February 1973, p. 1.

protection. The co-op is a viable alternative to the problem of inadequate supply of clean-up in the face of uncertain demand. To carry the original analogy of the "firehouse dilemma" one step further, a solution for those who demand clean-up beyond the commercial capability is the development of a volunteer "firehouse" organization where members support an oil spill cooperative.

The concept of cooperatives can be considered a form of insurance, much the same way as prepaid clean-up discussed earlier. It is to the advantage of all firms who handle large quantities of oil to have protection available to them should a large spill should occur. As discussed earlier, such protection is difficult to encourage in the commercial sector due to the degree of uncertainty in demand for these large activities. Individual protection on such a large basis would be cost prohibitive. Cooperation with other firms facing the same demand helps to spread the cost of such protection and assures each company that protection is available if needed. The possibility of two members requiring the full capability of a co-op is remote based on present utilization. Therefore several firms can jointly purchase equipment and expertise that otherwise would have to be maintained separately. The co-op allows protection at a fraction of the cost.

The six cooperatives located on the West Coast have a common purpose of unified protection, however there is no centralized control over these cooperatives. As a result they vary both in the extent of commitment and the organizational structure.

One role of the cooperatives can be described as that of a coordinator. This service exemplifies to some degree all co-ops. At present one cooperative exists on the West Coast where coordination is the sole function. Such coordination brings together all firms which require clean-up protection and provides a common exchange of information. Moreover, it supplies an organization through which mutual assistance

plans can be developed. One cooperative even provides a coordination of purchases so all members can take advantage of group discounts on clean-up equipment. Supervision on the actual clean-up operations ~~need not come~~ from the co-op personnel but rather from a management team drawn from member firms in the co-op.

From this basic coordinator role other functions are often added to develop the co-op into an autonomous clean-up agency supported on a non-profit basis by member companies. One added function includes the purchase of equipment by the cooperative, not by the individual members, to remain as cooperative owned and controlled equipment. Operating personnel for such equipment can be either drawn from the member organizations or from a subcontractor. If sufficient clean-up demand existed for the co-op, personnel could be maintained full time as part of the co-op staff. This, however, is not presently done on the West Coast. Preference is most often given to a prime subcontractor for operating requirements. Such a prime subcontractor is a commercial firm but most often not a commercial clean-up firm. The subcontractor normally has a contract to operate equipment solely for the co-op rather than offer clean-up services on the side. Of the six co-ops on the West Coast, three have prime subcontractors which are not included as a firm in the commercial Clean-up sector. Another has no prime subcontractor but rather numerous small subcontractors, again not in the commercial clean-up sector. These four co-ops provide supervision capability from within the member firm on a pre-arranged volunteer basis.

If clean-up is conducted for a non-member firm these supervisory services are charged at cost. A final development of the cooperative is the integration of commercial and non-profit functions. One of the cooperatives on the West Coast has adapted this integration by choosing a member of the commercial sector as a prime subcontractor. This enables the expertise and capability of

the existing commercial clean-up firm to be applied to the effort of the oil spill cooperative. In this case supervisory as well as operating services are subcontracted out. Also in this situation the commercial clean-up firm maintains and operates all equipment during clean-up operations. The co-op utilizing this approach is in essence purchasing a package clean-up for its members. When the commercial and non-profit functions are integrated the co-op is complementary, not competitive with the existing commercial sector. All that differentiates commercial from non-profit clean-up is whether the commercial contractor is required to incorporate co-op purchased material in clean-up.

A clear difference between the activity of the commercial firm and the activity of the firm as a prime subcontractor for the co-op is difficult to ascertain with the integrated firm. Member firms in the co-op still support the co-op on a pro-rated basis. The clean-up equipment which has been purchased by member assessments is turned over to the prime subcontractor who operates it for the co-op. If a member firm is in need of clean-up, the use of the co-op purchased equipment would not be charged to him, and the other costs of materials and labor would be charged at a pre-arranged rate. Non-members would pay for use of co-op purchased equipment as it would for other equipment of the commercial clean-up firm. Revenue received on the co-op equipment would help defray costs of the equipment.

A similarity is evident between the subscription or prepaid clean-up of a company discussed in Chapter V and co-op support. Theoretically the support of a commercial clean-up firm by several companies desiring protection would be no different than the same companies supporting a co-op as members and the co-op in turn supporting a clean-up firm through equipment and financial subsidy. The difference is that a co-op allows member firms a direct say in what

protection the region should have to facilitate oil clean-up. These member firms jointly decide how their support to a clean-up entity is utilized. It might also be argued that a commercial clean-up firm would fulfill the requirements requested by subscribing companies or stand to loose subscription payments. The cooperative however provides for the coordination of needs prior to support. This leaves no question as to the type of protection which will be offered by the co-op supported commercial firm.

No matter which format a cooperative takes, the existence of the co-op provides the organization and equipment support to accomplish clean-up which might otherwise not have been taken. The six co-ops have a combined clean-up inventory in excess of \$ 4 million with a majority of that presently held by four of the co-ops. Broken down into regions this accounts for \$ 1.5 million in the Northwest Region, \$ 1.1 million in the Central Coast Region and \$ 1.5 million in the Southern California Region. In total this \$ 4 million investment includes eleven coastal or harbor skimmers and approximately 25,000 feet of containment boom.

A measure of clean-up activity for the co-op is not as apparent as for a commercial firm. Clean-up costs are not comparable for members and non-members because of the different charge procedures for co-op owned equipment. Further where the prime subcontractor is also the commercial clean-up firm, it is impossible to determine the impact of just the co-op activity. Thus information is not available to develop accurate clean-up activity figures for the Non-profit Sector as a part of the Oil Spill Clean-up Industry.

Available data for the cooperatives does, however, demonstrate an important fact. Clean-up activity on any scale for the cooperative for the two and one-half years under consideration has been very low. One of the larger cooperatives operating under a prime subcontractor other

than a commercial clean-up firm had experienced nine clean-up operations in the two and one half years of the study. Of the total clean-up charges incurred by the costs of the co-op and subcontractors, ~~ninety~~ ninety-nine percent of the costs involved only two spills. These two spills involved firms which were not members of the co-op. The remaining spills of which only six involved members of the co-op were very small. In addition on several other occasions advisory services were made available at no cost. Another large co-op reported no clean-up costs incurred at all in the two and one half years. This co-op did however loan equipment to at least one spill not in its area of responsibility as a back-up measure. For the first six months of 1974 less than ten spills could be documented which were acted on by the West Coast co-ops. The total cost was less than \$100,000 with over 90 percent attributed to one spill by a non-member of the co-op. In 1973 the co-ops cleaned up fewer than five documented spills, with one moderate spill, the Oakland Estuary Spill accounting for over 90 percent.

Originally the non-profit sector was introduced to demonstrate an alternate source of clean-up in the face of demand which was not being met by the commercial sector. The capability of clean-up for the co-ops has been demonstrated to be large compared to the commercial sector but the utilization has been quite small. This can be primarily attributed to the purpose of the cooperatives, that of providing protection in the event of the large spill. During the time frame of this study, only three moderate and no major spills have occurred. Additionally, co-ops were founded and developed within this two year period, with much of the major clean-up equipment having just been received in late 1973 or 1974. Even with this low utilization of the co-ops to date, it is only through the support of such co-ops that equipment can be brought together and made available to members as well as non-members.

Future plans hold the possibility of a seventh co-op being established in the offshore area of Southern California in connection with the proposed offshore oil leases. This co-op, named the Outer Continental Shelf Co-op (OCS Co-op) is being strongly considered by companies contemplating operation in the offshore area. Whereas other co-ops generally pro-rate support by the vulnerability of the individual members, this non-profit clean-up entity would divide the support evenly among all members for initial establishment and then pro-rate costs after offshore activity is in operation. The first year budget alone is expected to be in excess of \$ 4 million. The OCS Co-op tentatively plans to purchase three ocean skimmers larger than any equipment presently on the West Coast. Two of the skimmers would be 86 feet in length, have a 200 barrel capacity and cost \$ 1.5 million each. The third would be 108 feet in length and cost \$ 2.3 million. The combined total of these three skimmers would exceed the total value of all commercial and non-profit equipment presently on the West Coast.

VIII• PUBLIC SECTOR

The Oil Spill Industry is influenced both by the government's demand for clean-up and supply of clean-up capability. Since government facilities and ships are a potential source of oil spills there exists a demand for clean-up in the event of a spill. The Federal Government also has the responsibility to provide for clean-up of certain non-government spills. Such responsibility exists where proper clean-up action has for one reason or another not been taken. Limited in-house clean-up equipment is maintained by the government, primarily by the Navy, to respond to spills from government vessels. Further the government maintains some specialized clean-up capability with the Coast Guard Strike Force for incidents where adequate clean-up of spills from both government and non-government sources might not otherwise be available. Even though the government is both a demander and supplier of clean-up, it does not attempt to provide government owned clean-up capability to meet all potential government demand. It must rely to some extent on the Commercial and Non-profit Sectors for clean-up. Because of this overlap the Public Sector must be discussed as a part of the Oil Spill Clean-up Industry.

A• GOVERNMENT CLEAN-UP DEMAND

Of initial interest is the extent to which government demand for clean-up has supported the other sectors of the industry. Government requirements for clean-up of in-house spills have primarily been due to the Navy, Coast Guard and other government owned vessels located on the West Coast. Navy vessels and facilities in the past have relied heavily on the commercial firms for clean-up, but since 1970 have been adding government-owned equipment. At present the extent to which the Navy relies on commercial contracts varies with the individual Naval activity. The best available data gathered by the author indicates that

clean-up contracts for all of the West Coast Navy activities totaled \$258,000 for 40 clean-up incidents in 1972, \$330,000 for 45 incidents in 1973, and \$90,000 for 13 incidents in the first six months of 1974. A majority of these spills were minor with the exception of one moderate spill in 1972, four moderate spills in 1973, and one in 1974.

The purchase of commercial clean-up for spills other than from government sources is authorized by the Coast Guard. The Coast Guard has the responsibility to respond to spills of an unidentified source or where the spiller will not or cannot assure adequate clean-up. Such spills are financed from the Revolving Fund of \$20 million (\$35 million authorized) to be administered by the Coast Guard.¹⁰ If the spiller is known, reimbursement to the Revolving Fund is sought. Reimbursement is not always obtained, however, due to several exceptions and a limit of liability which can apply. The Coast Guard authorized and finances the clean-up of such spills most often through the Commercial Sector although on some moderate spills the Non-profit Sector has been contracted to coordinate clean-up. In at least one state payments from the Revolving Fund are occasionally made to a state agency which in turn contracts with a commercial firm to conduct clean-up. It has been the practice not to utilize government clean-up equipment or personnel on spills where adequate commercial clean-up is available.

Had it not been for expenditures through the Revolving Fund, a number of spills would have gone unattended. Revenue and clean-up activity in the Commercial Sector also would have been diminished. The government by including this additional category of unclaimed spills has therefore contributed to the commercial revenue. It also has depicted a more accurate demand for clean-up within a time period by

¹⁰Wallace, Captain S. A., U. S. Coast Guard, "U. S. Coast Guard Environmental Protection Program", Navy Oil Spill Control Conference, 1-4 May 1972, p. 26.

attempting to include all spills. Even so there is little dispute that some spills which could be cleaned up go undetected. The extent of government clean-up through the Revolving Fund is presented in Table 4-A. Only a negligible portion of the Revolving Fund expense, except for the one spill specified, went to firms other than in the commercial clean-up sector.

The total clean-up activity administered by the Coast Guard through the Revolving Fund for 1972, 1973 and the first six months of 1974 represents a sizable contribution to the commercial sector. The percentage of contribution by the Revolving Fund to total commercial clean-up is presented in Table 4-B. Although this contribution fluctuates from period to period, an average contribution of the Revolving Fund is 10 percent.

B. GOVERNMENT CLEAN-UP CAPABILITY

Clean-up equipment is owned by the Navy for use on in-house spills. Navy equipment is located on the West Coast through out sixteen different locations in the three Naval Districts. In total this equipment includes approximately 37,000 feet of containment boom valued at \$300,000 and ten harbor skimmers valued at approximately \$200,000. This equipment is intended primarily for clean-up of Navy spills at the location of storage. This includes eight thousand feet of boom and three skimmers which are maintained by NAVSHIPS (SUPSALV) for offshore clean-up and salvage not only for the West Coast but for the Pacific Basin.

Documentation of the utilization of Navy owned equipment is not readily available. Clean-up costs to the Navy are the only figure which will give an indication of equipment utilization. One Naval District had complete cost data for the first six months of 1974. During that time period there were 134 spills reported or sighted within the area of responsibility. Only 63 of these were of a size large

TABLE 4-A

Revolving Fund Finance of Clean-up
by dollars and (number of incidents)

	1972	1973	1974 (6 Mo)
Northwest	27,376 (10)	95,273 (40)	99,720 (17)
Central Coast	39,380 (10)	159,927 (30)	15,610 (17)
		1,241,822 (1) *	
Southern Cal	10,281 (8)	56,177 (15)	17,715 (8)
TOTAL	80,037 (28)	311,375 (86)	182,538 (53)
		1,553,199 (86) *	

TABLE 4-B

Revolving Fund Contribution to Commercial
Clean-up Revenue
(percent)

	1972	1973	1974 (6 Mo)
Northwest	16.3	12.6	42.0
Central Coast	6.3	19.3	9.5
Southern Cal	1.6	6.0	2.2
Total	5.7	12.4	15.2

* Includes moderate spill cleaned up under contract to non-profit sector.

enough to warrant any clean-up action. A cost figure based on manpower and material for these 63 spills was estimated by the Navy at \$10,782. Although such limited data is insufficient to draw any definite conclusions of the in-house government clean-up activity as a share of the total industry, it does verify that Navy clean-up effort is directed towards small spills such as tank overflows and bilge pumpings. Partial data observed from the other two Naval Districts confirms the development of the small spill clean-up capability. The Navy then is developing a first strike clean-up force comparable to that of the Private Sector. Inefficient or inexperienced clean-up personnel may be reflected in much longer clean-up times and higher costs.

The Coast Guard maintains a clean-up capability not directed at its own potential to spill but rather towards those spills where the clean-up capability of the private, commercial or non-profit sectors might not be adequate. The Coast Guard Strike Force, headquartered for the West Coast in San Francisco, is capable of responding anywhere in the West Coast or even in the United States to a moderate or major spill where other sectors of the industry are unable to respond.

The Strike Force presently has assorted equipment valued at \$650,000 for use in clean-up response. This includes speciality items such as 1800 feet of high seas containment boom, and seven ADAPTS, high-capacity pump systems for removing oil from a stricken vessel. A recent example of the Strike Force capability was in August 1974 when the METULA, a supertanker carrying enough petroleum to supply one tenth of the U. S. daily consumption, ran aground in the Straits of Magellan. Although 50,000 tons was spilled into Chilian waters, the Coast Guard's use of an experimental system to remove the remaining 1,140,000 tons from the

disabled ship, "kept it from beccmming a major disaster in the view of enviromentalists and shipping officials."¹¹

For the two and one half year period of this study, the Strike Force responded to twelve different spills. These spills were of moderate size and larger, or they constituted a specific situation where government assistance was required. Six of these spills did not require actual government assistance in clean-up, the only role was to monitor clean-up operations. The other six spills, however, involved government equipment and personnel as a part of clean-up. Once again no specific measure of cost exists which can be related to revenue consistant in the commercial sector. Government costs charged directly to these six spills totaled less than \$50,000. Such figures as a measure of activity are completely misleading due to the many aspects of government clean-up not charged directly. As an example in one spill attended to by the Strike Force, three thousand feet of boom was employed for 14 days. Government costs amounting only to damage of the boom totaled \$7,000 while rental costs on a commercial basis would have approached \$42,000.

No comparable indicator as a measure of clean-up activity exists for the Strike Force. Yet since the government is not directly competing with any other sector, such a comparison is not essential. Rather than competition, the Strike Force provides a specialized clean-up force supplementary to the other services available throughout the industry.

One additional source of clean-up is the equipment purchased through commercial channels and stockpiled by the Coast Guard. This equipment is located in seven different areas on the West Coast where effective industry or co-op organizations or company owned resources do not exist. This

¹¹"Tanker Spill Stir s New Concern", Monterey Peninsula Herald, (Washington Post Service), October 28, 1974, p. 2.

equipment is also supplementary in nature to the other sectors, but is available for quick response in remote areas should a spill occur. This stockpiled equipment is not designated for use by the Strike Force, but rather by any agency or firm in need of equipment. Stockpiled equipment is valued at \$70,000 and includes 9,700 feet of assorted containment boom. No utilization figures were available on this stockpiled equipment.

The presentation of any cost data for government clean-up must be qualified. Even costs based on manpower and material are subject to wide variation between government facilities. Cost of military personnel are calculated at military pay rates, which differ from commercial pay scales. One additional factor is personnel efficiency. Government clean-up efforts benefit from other government resources not intended specifically for oil spill clean-up. Government small-boats help with clean-up while aircraft assist in surveillance at either no charge or a rate different than comparable commercial services.

C• OTHER GOVERNMENT INFLUENCES

To date the government influence is primarily through an in-house capability to clean-up its own spill or to assist beyond the capacity of the various sectors. It might be questioned that if uncertainty is really a dilemma, then why should government not maintain a massive clean-up capability just as municipal governments maintain fire protection.

In the past both California and Washington State have proposed the establishment of a "barrel tax" from two to five cents per barrel of petroleum.¹² Such a tax would have enabled these states to have financed not only an extensive enforcement program, but also a clean-up capability.

¹²California State Senator Nedjedly, Contra Costa County, proposed a barrel tax for California in 1971. Washington State Department of Ecology proposed a similiar tax for Washington in 1973.

Neither of the proposed taxes were ever passed. One reason suggested by several persons for the failure of the California tax was the development of a non-profit clean-up capability by the petroleum industry. At present government maintenance of extensive clean-up equipment for all spills would be a duplication of existing capability in the other three sectors.

IX• INTERACTION OF SECTORS IN THE INDUSTRY

Just as an examination of the economics of oil spill clean-up must include the various sectors of the Oil Spill Clean-up Industry, so too must the interaction between these sectors be considered. No interaction occurs where clean-up services are required by a party outside the industry. However when firms from the various sectors of the industry work together on a spill, such as a commercial firm subcontracting for a co-op, then an overlap in the total clean-up activity must be recognized.

A• OVERLAP OF SECTORS

A non-profit firm can assume the role as a coordinator of subcontractors and private sector firms in addition to providing clean-up with co-op equipment. Likewise the government can finance a clean-up which is carried out by a co-op or commercial clean-up firm or even both. With such interaction there exists the possibility that reported clean-up activity from one spill might be duplicated within the various sectors. A summation of activity of all sectors would exaggerate the total clean-up effort expended. A recent spill can be discussed to demonstrate this fact.

1. Oakland Estuary Spill

On 18 January, 1973 approximately 171,000 gallons of waste oil was dumped into the Oakland Estuary from storage tanks. The bulk of clean-up lasted seven days and reached a total cost of \$ 1.2 million.¹³ The clean-up of the spill was financed entirely by the Federal Government through the Coast Guard Revolving Fund. The Coast Guard activated the Strike Force and available government-owned equipment, but contracted the major task of clean-up to the local cooperative, Clean Bay, Inc. The co-op in turn activated its clean-up capability but also contracted out

¹³Clean Bay Inc., Cleaning Up the Oakland Estuary Spill, January 19 - 26, 1973, p. 7.

operation of co-op owned equipment and many other tasks. In total this clean-up operation involved 12 government agencies (six federal, three state, and three municipal), two private agencies, 48 contractors (only three of which were a part of the commercial clean-up sector), and the one co-op with 10 member companies.

An overlap of clean-up effort could become quite entangled in such an example. Of the total cost of clean-up paid by the Federal Government, approximately 75 percent was channeled to the co-op. The other 25 percent was paid directly by the Coast Guard to private contractors, other government agencies involved in the spill, as well as direct payment of claims. Of the total clean-up cost the three firms of the commercial clean-up sector received less than 33 percent. Non clean-up firms such as construction contractors adapted themselves for clean-up on a short term basis and one such firm accounted for just under 10 percent of the total cost. This is a distribution of total costs that is not at all uncommon for other moderate or even large spills.

B• COMPLIMENTARY RESOURCES OF SECTORS

Another form of interaction is the complimentary nature of the clean-up resources when equipment from several sectors is combined. The non-profit firms often hold a different type of inventory than the commercial firms or the government. The larger equipment of the non-profit organizations often needs the smaller capability of commercial firms to compliment the entire clean-up effort. The existence of such complimentary action strengthens the need for each of the sectors within the Oil Spill Clean-up industry.

X• CONCLUSIONS

At the onset of this study it was assumed that the occurrence of oil spills was random and therefore unpredictable. The purpose was to determine to what extent the clean-up firms do operate in a "firehouse dilemma" of uncertain demand, and then to seek to understand their solution for contending with the problem. The discussion of the industry required that commercial firms, which must deal with demand uncertainty while seeking revenue, be differentiated from other sectors where clean-up is not explicitly profit oriented.

After examining gross revenue from clean-up as a measure of past activity for commercial firms, it appeared that for the three geographical areas total revenue from clean-up did display uncertainty over time. It also became evident that the clean-up industry is faced with a two part demand; minor and catastrophic spill clean-up. Commercial firms have concentrated their supply of clean-up capability towards the minor spill due to the high cost for large-scale equipment required on the moderate and major spills. This has not precluded the commercial firms from contributing on the large-scale clean-up incidents, but they are able to contribute only up to the limit of their capability rather than conduct the entire clean-up of the larger spills.

The study disclosed that the impact of demand uncertainty is not the same for all firms because the dependence of commercial firms on clean-up activity as a source of revenue varies with the firm. The commercial sector was divided into the pure firms, those highly dependent on clean-up, or the secondary firms where oil clean-up activity constituted only a small portion of total operations for the firm. During the period covered by the study, a trend was observed for increased dependence on other than clean-up activities by all but one firm. For

those firms originally heavily dependent on clean-up this shift was toward clean-up related activities.

Of particular significance in the study was the compilation of recent data concerning the Oil Spill Clean-up Industry. It was determined that the nine firms shared a 2.4 million-dollar-per-year- industry. Although the data for the first six months of 1974 suggested an upward trend in the commercial sector activity, the uncertain nature of clean-up prevents any prediction of how much growth, if any, will take place in the commercial sector.

Other trends of the study showed an increased capability on the part of the private sector and the government for in-house clean-up. Such increases in clean-up by the other sectors imply that many small spills once serviced by the commercial sector are now going to be conducted in-house rather than be contracted out. While the loss of a government contract in one area was evident in the temporary reduction in activity, a wide reduction in commercial activity is not yet evident.

After examining the increased in-house capability within the industry, a premature conclusion might suggest the commercial sector is being replaced by the private, non-profit or public sector. Conversely, however, this author concludes that much of the new in-house impact will enable many spills previously not cleaned up now to be serviced. Instead of a time delay for commercial equipment to arrive on scene, private equipment can immediately be utilized. It is further suspected that immediate containment by the spiller will provide commercial contractors more clean-up activity when they do arrive on scene for spills that exceed private capability. This would be true where more oil was immediately contained and therefore subject to clean-up. The continued importance of the commercial sector is still evident as a part of the Oil Spill Clean-up Industry.

The oil spill cooperatives have been highly publicized

due to the recent purchases of large scale clean-up equipment. Further the Coast Guard Strike Force response capability to potential disasters attracts considerable attention. The non-profit area of clean-up is expected to expand as suggested by the formation of the Outer Continental Shelf Co-op. Large scale clean-up from these two sources will provide capacity that appears to be not forthcoming from within the commercial sector. The "firehouse dilemma" originally posed has been solved in the following manner. A capability for clean-up of the large scale spills has been met in a cooperative fashion by those industries who have the potential to require such clean-up services. It appears the commercial firms have chosen to specialize in the minor and more predictable clean-up. The non-profit sector and subscribers to commercial firms have provided an alternative to the commercial sector which chose not to supply the large scale clean-up under uncertainty. It is expected that future clean-up capability for large scale spills will continue to be provided by cooperatives, not from a comprehensive government sponsored clean-up organization.

APPENDIX A
Commercial Clean-up Firms

Marine Oil Pickup Service - MOPS
Pier 17 Harbor Island
P.O. Box 3783
Seattle, Washington 98124

Oil Spill Services Inc.
12422 68th Ave N.E.
P.O. Box 548
Kirkland, Washington 98033

Western Pacific Salvage Division
Willamette Tug & Barge Co.
Foot of N. Portsmouth Ave.
Portland, Oregon 97203

Pacific Pollution Control
800 Grayson Street
Berkely, California 94710

H & H Ship ServCes
Foot of Channel Street
San Francisco, California 94248

Industrial Tank Inc.
210 Berrellesa Street
P.O. Box 831
Martinez, California 94553

Crosby & Overton, Inc.
1620 West 16th Street
Long Beach, California 90813

Wm. H. Hutchison & Sons Inc.
217 North Lagoon Avenue
Wilmington, California 90774

Pepper Industries Incorporated
2000 McKinley Avenue
National City, California 92050

APPENDIX B

Non-profit Clean-up Organizations

Clean Seas Incorporated
18 Marina Center Building
Santa Barbara, California 93109

Petroleum Industrial Coastal
Emergency Cooperative (PICE)
555 E. Ocean Blvd., Suite 510
Long Beach, California 90802

Humboldt Bay Oil Spill Co-op
P.O. Box 1004
Eureka, California 95501

Clean Rivers Cooperative
2416 North Marine Drive
Portland, Oregon 97217

Clean Sound
2406 13th Avenue S.W.
Seattle, Washington 98134

Clean Bay Inc.
2280 Diamond Blvd. Room 220
Concord, California 94520

Oil Spill Cleanup Information

Part I	1972	1973	1974 (First six months)
1. No. spills experienced by company	_____	_____	_____
2. No. spills cleaned up by company personnel and equipment	_____	_____	_____
3. No. spills where company assisted commercial cleanup	_____	_____	_____
4. No. spills cleaned solely by commercial cleanup	_____	_____	_____
5. No. CO-OP cleanups assisted by company	_____	_____	_____

Part II

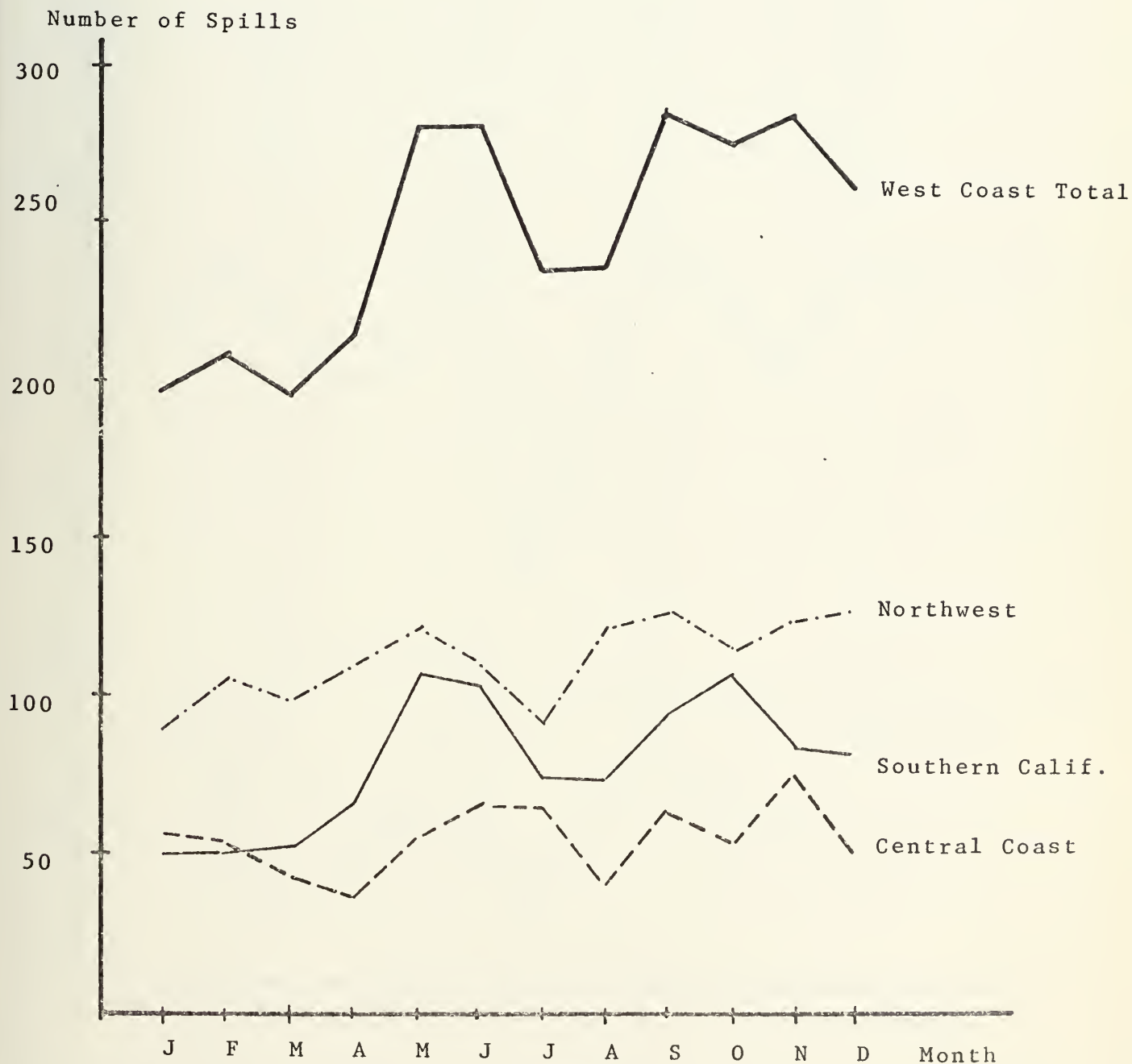
1. Costs in item # 2 above	_____	_____	_____
2. Costs of your cleanup in item # 3 above	_____	_____	_____
3. Costs of your cleanup in item # 5 above	_____	_____	_____

Part III

1. No. of oil skimmers of following type:	Ocean _____
	Coastal _____
	Harbor _____
2. Amount of boom on hand	
3. Dollar value of total cleanup equipment inventory	\$ _____

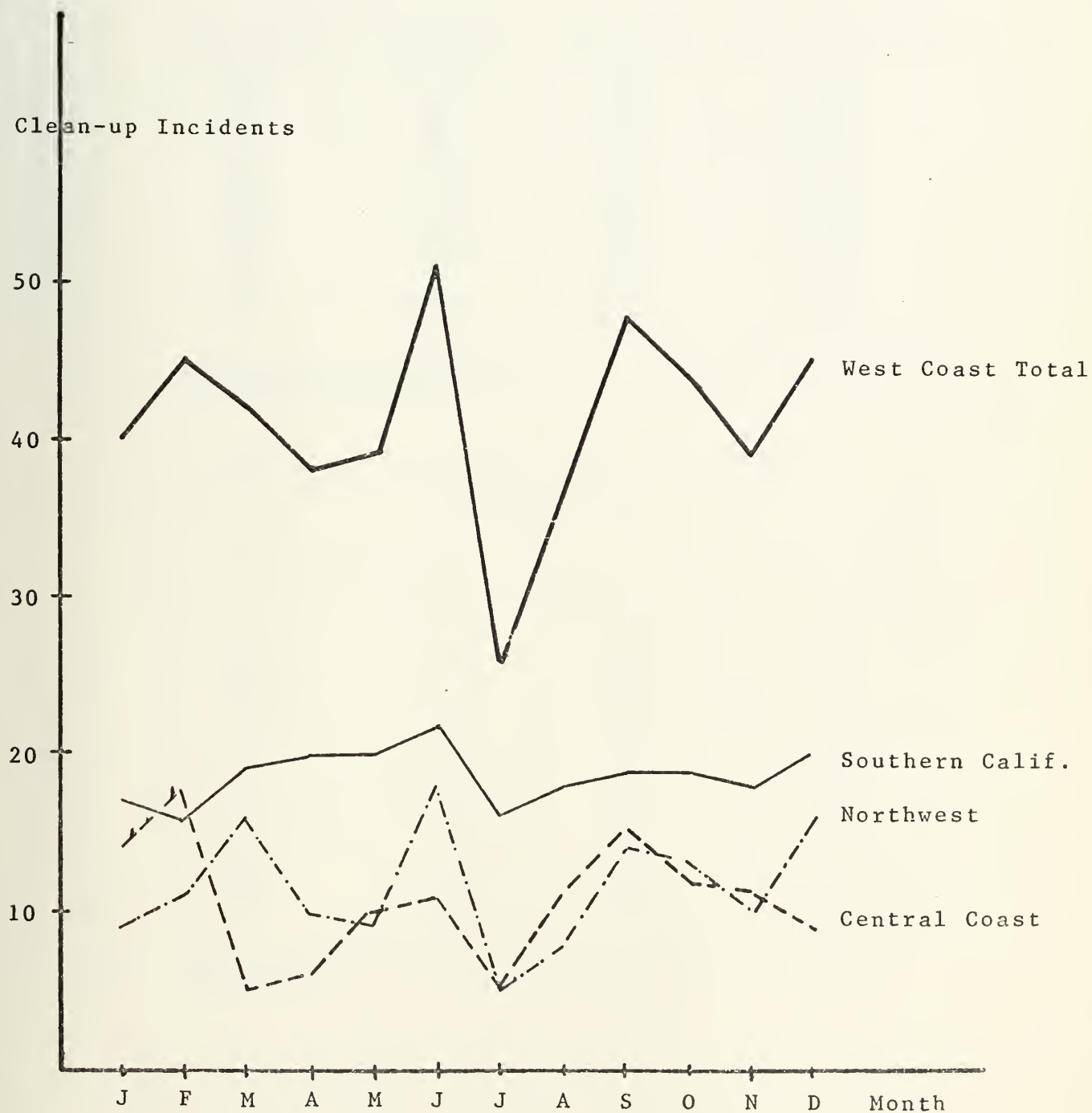
Please return to: Christopher M. Stone
390-B Ricketts Road
Monterey, Cal 93940

FIGURE 1
Reported West Coast Oil Spills
1973



Source: Department of Transportation, U.S. Coast Guard unpublished data.

FIGURE 2
West Coast Commercial Clean-up Incidents
1973



Source: Data collected from commercial clean-up firms by author.

TABLE 5
West Coast Oil Spill Incidents
1973 by month
(Data for Figure 1)

	Northwest	Central	Southern	West Coast Total
jan	50	56	90	196
feb	50	53	105	196
apr	67	37	110	214
may	105	54	121	280
jun	103	66	111	280
jul	77	66	91	234
aug	75	40	121	236
sep	94	64	126	284
oct	107	53	114	274
nov	83	76	124	283
dec	81	51	128	260
Total	944	660	1340	2944

source: Department of Transportation, U.S.Coast Guard unpublished data.

West Coast Oil Spill Clean-up Incidents
1973 by month

(Data for Figure 2)

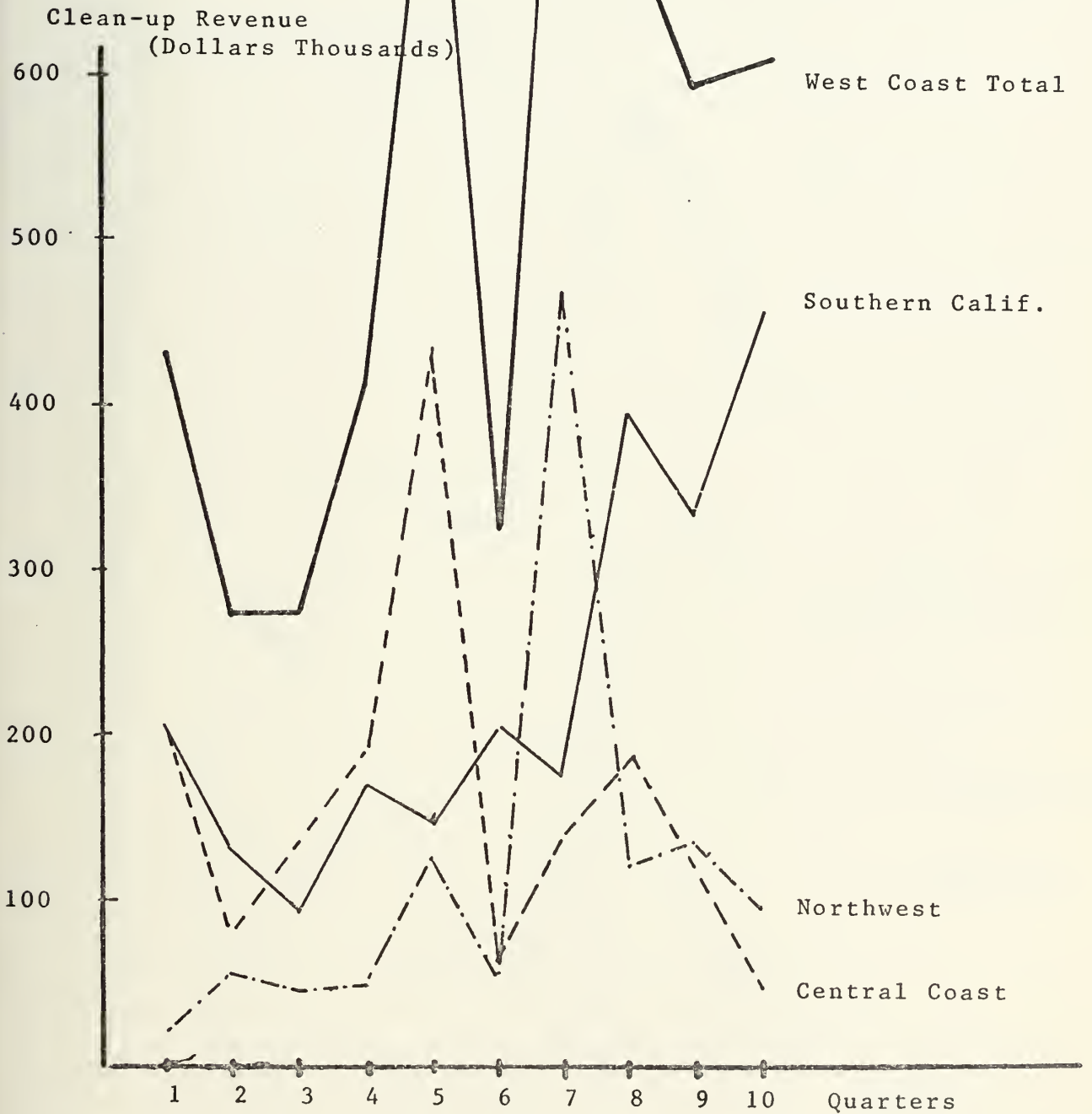
jan	9	14	17	40
feb	11	18	16	45
mar	16	7	19	42
apr	10	8	20	38
may	9	10	20	39
jun	18	11	22	51
jul	5	5	16	26
aug	8	11	18	37
sep	14	15	19	48
oct	13	12	19	44
nov	10	11	18	39
dec	16	9	20	45
Total	139	131	224	494

Source: Data collected from commercial clean-up firms by author.

FIGURE 3

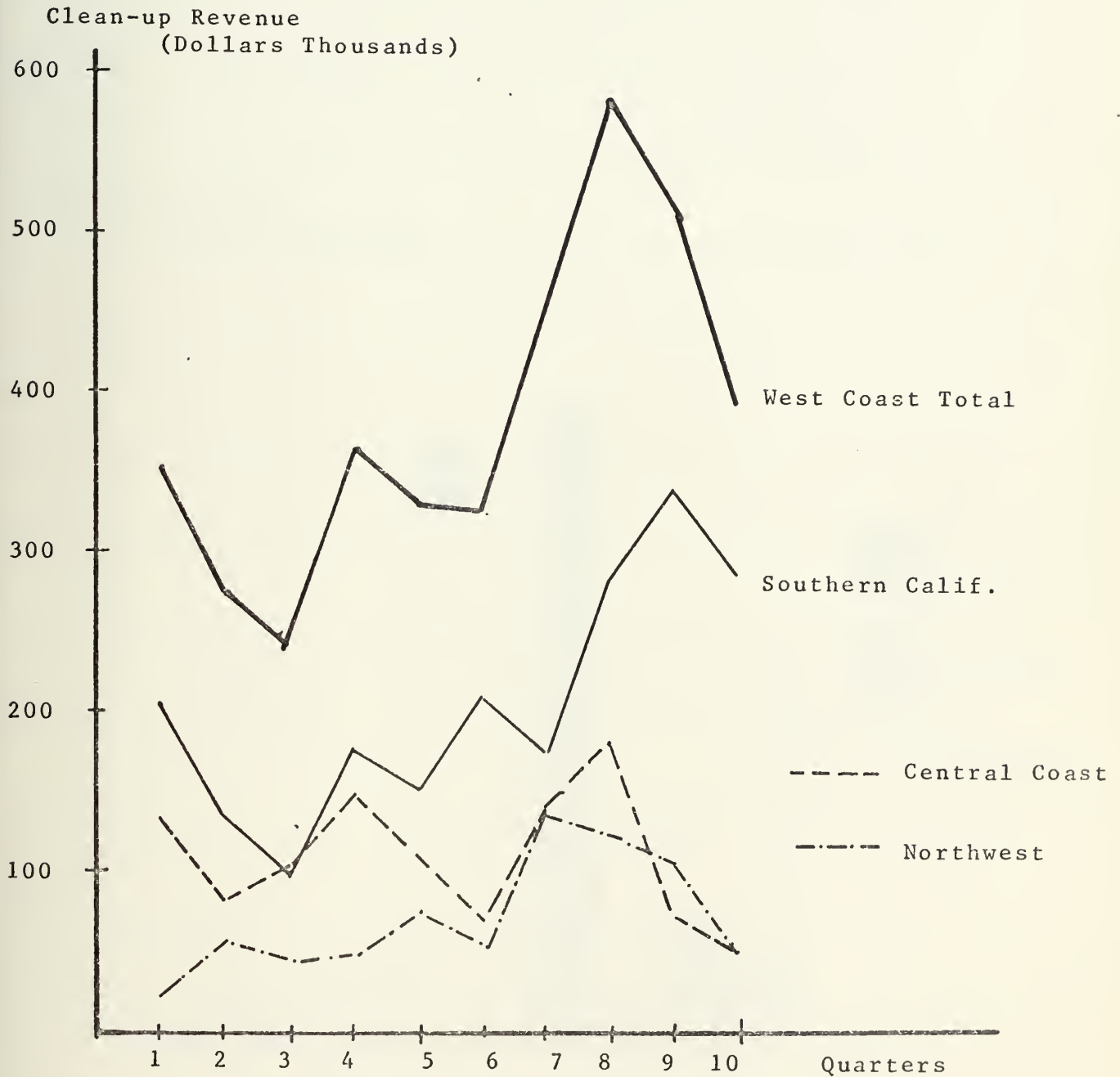
Total Clean-up Revenue

1972 -- June 1974



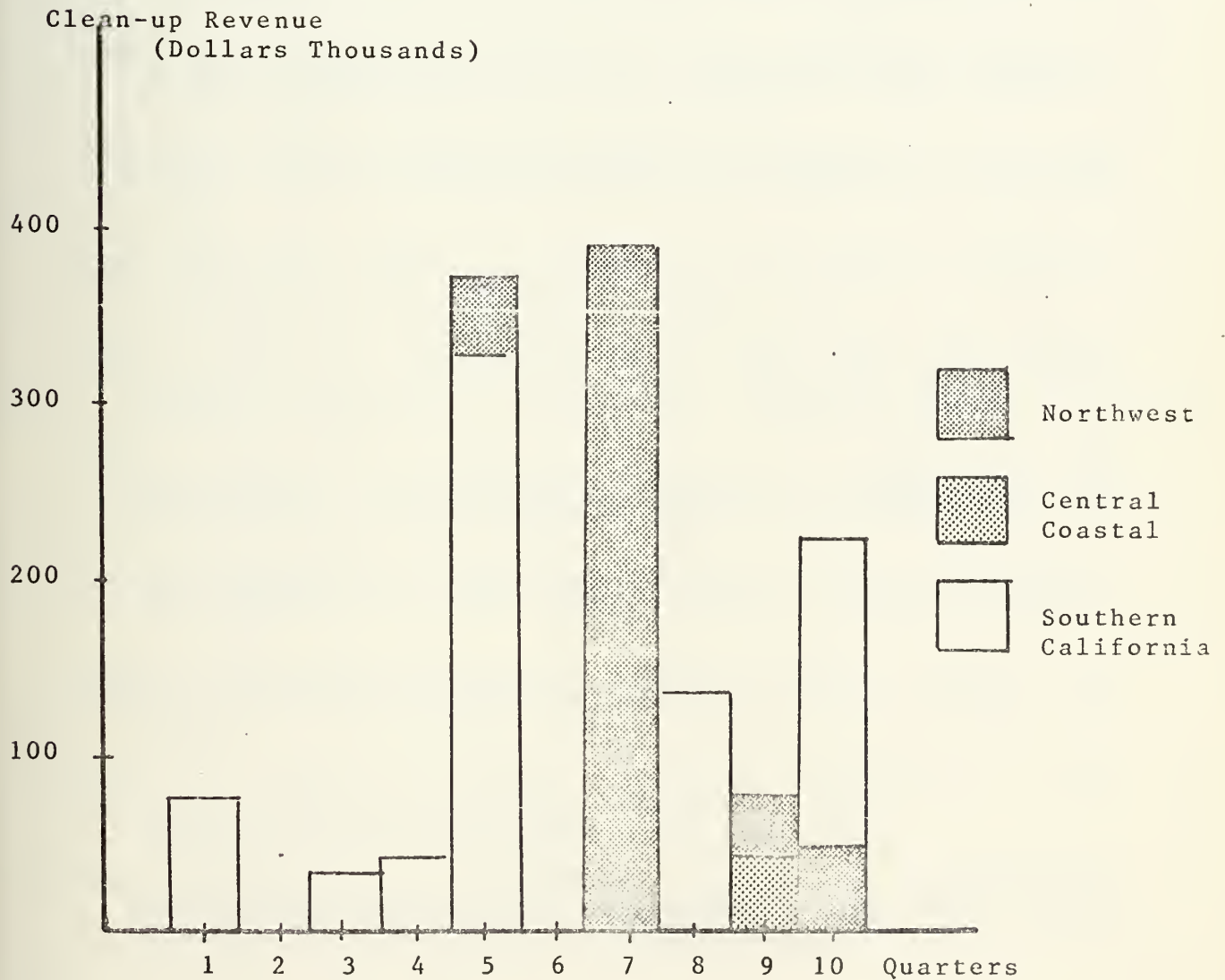
Source: Data collected from commercial clean-up firms by author.

FIGURE 4
 Minor Clean-up Revenue
 1972 -- June 1974



Source: Data collected from commercial clean-up firms by author.

FIGURE 5
Major Clean-up Revenue
1972 -- June 1974



Source: Data collected from commercial clean-up firms by author.

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20. Captain A. J. Bush 1
Petroleum Industrial Coastal
Emergency Cooperative (PICE)
555 E. Ocean Blvd., Suite 510
Long Beach, California 90802

21. Mr. Jack Butler 1
Humboldt Bay Oil Spill Co-op
P.O. Box 1004
Eureka, California 95501
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Clean Rivers Cooperative
2416 North Marine Drive
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Clean Sound
2406 13th Avenue S.W.
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24. Mr. Reese W. Norton 1
Clean Bay Inc.
2280 Diamond Blvd. Room 220
Concord, California 94520
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